US-PAT-NO: 6204940

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TITLE: Digital processing of scanned negative films

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INVENTOR-INFORMATION:

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ABSTRACT:

A process and apparatus is described to improve the digital processing of scanned negative films by reducing the amount of time necessary to perform the process and by increasing the robustness and quality of the images produced. These benefits are achieved by a process of color inversion, white point and

black point mapping, and **midtone** adjustment. White and black mapping increases
the dynamic range of the image, as well as removes the color cast of the
negative film. A backlit image postprocessing algorithm can be employed which
uses heuristics to identify backlighted situations, which are then brightened
using a nonlinear power mapping. A **midtone** adjustment can include the
sub-steps of contrast reduction and color adjustment. Contrast reduction
reverses the film exposure characteristics. Color adjustment removes the
remaining color cast in the **midtone** region of the image, and obtains the
correct brightness. Starting from images with poor contrast and color cast,
the system automatically looks for the appropriate correction parameters to
produce images with vivid color and good contrast. This is achieved without
rescanning or retaking the picture. One implementation, using one dimensional
look-up-tables, is very efficient.

22 Claims, 8 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 8

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Abstract Text - ABTX (1):
A process and apparatus is described to improve the digital processing of
scanned negative films by reducing the amount of time necessary to perform the

process and by increasing the robustness and quality of the images produced. These benefits are achieved by a process of color inversion, white point and black point mapping, and **midtone** adjustment. White and black mapping increases the dynamic range of the image, as well as removes the color cast of the negative film. A backlit image postprocessing algorithm can be employed which uses heuristics to identify backlighted situations, which are then brightened using a nonlinear power mapping. A **midtone** adjustment can include the sub-steps of contrast reduction and color adjustment. Contrast reduction reverses the film exposure characteristics. Color adjustment removes the remaining color cast in the **midtone** region of the image, and obtains the correct brightness. Starting from images with poor contrast and color cast, the system automatically looks for the appropriate correction parameters to produce images with vivid color and good contrast. This is achieved without rescanning or retaking the picture. One implementation, using one dimensional look-up-tables, is very efficient.

Brief Summary Text - BSTX (12):

A process and apparatus is described to improve the digital processing of scanned negative films by reducing the amount of time necessary to perform the process and by increasing the robustness and quality of the images produced. These benefits are achieved by a process of color inversion, white point and black point mapping, and **midtone** adjustment. White

and black mapping increases the dynamic range of the image, as well as removes the color cast of the negative film. The black and white point mapping can result in a dark image when light sources, such as lit candles or incandescent bulbs, are visible in the scene. For one embidoment, a backlit image postprocessing algorithm is employed which uses heuristics to identify these situations, which are then brightened using a nonlinear power mapping.

Brief Summary Text - BSTX (13):

For one embodiment, **midtone** adjustment includes the sub-steps of contrast reduction and color adjustment. Contrast reduction reverses the film exposure characteristics. Color adjustment removes the remaining color cast in the **midtone** region of the image, and obtains the correct brightness.

Detailed Description Text - DETX (4):

Our process and apparatus improves the digital processing of scanned negative films by reducing the amount of time necessary to perform the process and by increasing the robustness and quality of the images produced. These benefits are achieved by a process of color inversion, white point and black point mapping, and **midtone** adjustment. White and black mapping increases the dynamic range of the image, as well as removes the color cast of the negative film. The black and white point mapping can result in a dark image when light sources, such as lit candles or incandescent bulbs,

are visible in the scene.
For one embodiment, a backlit image postprocessing algorithm is employed which
uses heuristics to identify these situations, which are then brightened using a
nonlinear power mapping.

Detailed Description Text - DETX (5):

For one embodiment, **midtone** adjustment includes the sub-steps of contrast
reduction and color adjustment. Contrast reduction reverses the film exposure
characteristics. Color adjustment removes the remaining color cast in the
**midtone** region of the image, and obtains the correct brightness.

Detailed Description Text - DETX (20):

Typically, the white and black mapping will vary with each negative scanned.
The white and black point mapping is followed by two stages that adjust the
image **midtone** characteristics, as shown in FIG. 2. FIG. 5 is a diagram
illustrating contrast reduction according to an embodiment of the present
invention. The purpose of contrast reduction is to "undo" the film exposure
characteristics (See, R. W. G. Hunt, The Reproduction of Colour in Photography,
Printing and Television, Fountain Press, England, 1987). The contrast
adjustment step applies a nonlinear remapping function to all three color
planes. This function is designed to adjust for some of the nonlinear
characteristics of the negative. For one embodiment, we use a parameterized
set of inverse sigmoidal functions for contrast

adjustment. If the input range x between shadow and highlight regions is normalized to [0, 1], the function takes the form:

Detailed Description Text - DETX (26):

Finally, the color balance is adjusted in the **midtone** regions. The purpose of color adjustment is to remove the remaining color cast in the **midtone** region of the image, and to obtain the correct brightness. For the **midtone** adjustment stage (which we implement as contrast reduction and color adjustment), we basically adjust for film nonlinearities and to properly map the neutral gray axis. The idea here is that black and white may be correct, but grays can still be off due to further nonlinearities in film and developing. We can use contrast reduction to adjust for film nonlinearities, which is a single curve applied to all three color planes. Color adjustment curves correct to properly map the neutral gray axis. This requires separate curves for each color plane (red, green and blue).

Detailed Description Text - DETX (27):

The three preceding processing stages can all be incorporated into a set of three one dimensional lookup tables, one for each color plane. For one embodiment, the curves corresponding to these lookup tables will be rotated clockwise by 45 degrees, added to a **midtone** adjustment curve, and rotated back 45 degrees counterclockwise. This procedure is illustrated for a single color

plane in FIG. 6A. Our **midtone** adjustment curves are computed as

Detailed Description Text - DETX (28):
where the input range is again normalized to [0, 1], and the parameter
.beta. is determined experimentally for each color plane. The **midtone**
adjustment will balance the colors in the **midtone** regions to remove color casts
along the neutral axis.

Detailed Description Text - DETX (29):
The **midtone** color adjustments are computed by rotating the input/output
characteristic to horizontal, adding an adjustment function, and rotating back.

Claims Text - CLTX (4):
**midtone** adjustment to form a positive image, wherein the step of **midtone**
adjustment comprises the steps of contrast reduction and color adjustment; and
wherein said contrast reduction step uses a curve having an inverse sigmoidal
shape.

Claims Text - CLTX (20):
a **midtone** adjuster to perform **midtone** adjustment to form a positive image,
wherein the **midtone** adjuster comprises a contrast reducer to perform contrast
reduction, and a color adjuster to perform color adjustment; and wherein the
contrast reducer uses a curve having an inverse sigmoidal shape.

Claims Text - CLTX (24):

18. The processor as set forth in 14, wherein at least one of the color inverter, mapper, and **midtone** adjuster uses a look-up table.

Current US Cross Reference Classification - CCXR (4):

**382/167**